**Question/Answer Booklet**

# CHEMISTRY

**NAME:** _____

**CLASS:** _____

*Time allowed for this paper*

Reading time before commencing work:       Ten minutes
Working time for paper:       Three hours

*Material required/recommended for this paper*

*To be provided by the supervisor*

This Question/Answer Booklet
Separate Multiple Choice Answer Sheet
Chemistry Data Sheet

*To be provided by the candidate*

Standard Items:    Pens, pencils, eraser or correction fluid, ruler

Special Items:    Calculators satisfying the conditions set by the Curriculum Council and a 2B, B or HB pencil for the Separate Multiple Choice Answer Sheet.

*Important note to candidates*

No other items may be taken into the examination room. It is **your** responsibility to ensure that you do not have any unauthorised notes or other items of a non-personal nature in the examination room. If you have any unauthorised material with you hand it to the supervisor **before** reading any further.

**STRUCTURE OF PAPER**

| Part | Number of questions available | Number of questions to be attempted | Suggested working time | Marks available | |
|---|---|---|---|---|---|
| 1 Multiple Choice | 30 | ALL | 55 | 60 | (30%) |
| 2 Short Answers | 11 | ALL | 60 | 70 | (35%) |
| 3 Calculations | 5 | ALL | 45 | 50 | (25%) |
| 4 Extended Answers | 1 | 1 | 20 | 20 | (10%) |
| | | | **Total marks** | **200 (100%** | |

*Instructions to candidates*

2. Answer the questions according to the following instructions:

   **Part 1** Answer **all** questions, using 2B, B or HB pencil, on the separate Multiple Choice Answer Sheet. Do **not** use a ballpoint or ink pen.

   If you consider that two or more of the alternative responses are correct, choose the one you think is best. If you think you know an answer, mark it even if you are not certain you are correct. Marks will **not** be deducted for incorrect answers.

   Feel free to write or do working on the question paper; many students who score high marks in the Multiple choice Section do this.

   **Part 2, 3 and 4** Write your answers in the space provided in this Question/Answer Booklet. A blue or black ball point or ink pen should be used

   Questions containing specific instructions to show working should be answered with a complete, logical, clear sequence of reasoning showing how the final answer was arrived at; correct answers which do not show working will not be awarded full marks.

3. The examiners recommend that candidates spend the reading time mainly reading the Instructions to Candidates and Parts 2, 3 and 4.

4. **Chemical equations**
   For full marks, chemical equations should refer only to those species consumed in the reaction and new species produced. These species may be **ions** [for example $Ag^+_{(aq)}$], **molecules** [for example $NH_{3(g)}$, $NH_{3(aq)}$, $CH_3COOH_{(\ell)}$, $CH_3COOH_{(aq)}$] or **solids** [for example $BaSO_{4(s)}$, $Cu_{(s)}$ $Na_2CO_{3(s)}$].

**SEE NEXT PAGE**

**PART 1**   **(40 marks)**

Answer ALL questions in Part 1 on the Separate Multiple Choice Answer Sheet provided, using a 2B, B or HB pencil.  Each question in this part is worth 2 marks.

1.   Which one of the following compounds will have geometric isomers, that is, cis and trans isomers?

(a)   1-fluoropropene

(b)   1,1-difluoropropene

(c)   1,1,2-trifluoropropene

(d)   2,3-difluoropropene

2.   Which of the following pairs of compounds are isomers?

I      and   
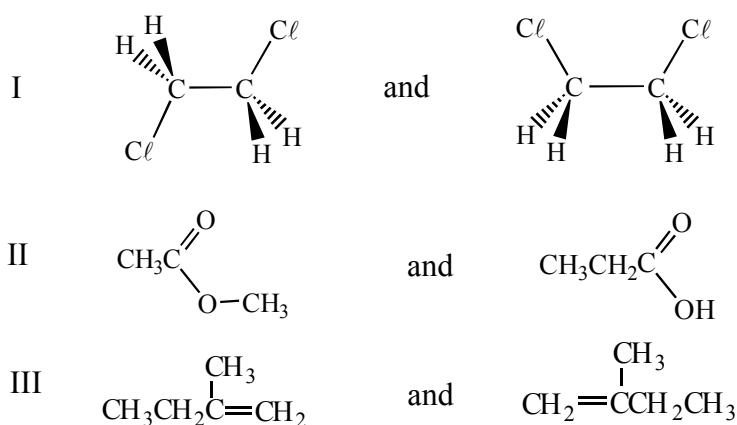
II      and   

III      and   

(a)   I only

(b)   II only

(c)   III only

(d)   I, II and III

3.   How many aliphatic structural isomers have the formula $C_5H_{10}$?

(a)   3

(b)   4

(c)   5

(d)   6

4.   Element X has an electron configuration $1s^2\, 2s^2\, 2p^6\, 3s^2$ and element Y has an electron configuration $1s^2\, 2s^2\, 2p^5$. The most likely formula for a compound formed from the two elements will be

(a)   XY

(b)   $XY_2$

(c)   $X_2Y$

(d)   $X_5Y_2$

**SEE NEXT PAGE**

5. A covalent bond can best be described as
   (a) an attraction between atoms that have permanent net charges.
   (b) an attraction between atoms and mobile valence electrons.
   (c) an attraction between the valence electrons in two different atoms.
   (d) a simultaneous attraction between a pair of electrons by the nuclei of two atoms.

6. Consider the compounds
   $H_2O$      $CaCO_3$      $(NH_4)_2S$    and   $SiO_2$

   The compounds that contain only covalent bonds between its atoms are
   (a) $H_2O$ and $(NH_4)_2S$ only.
   (b) $H_2O$ and $SiO_2$ only.
   (c) $(NH_4)_2S$ and $CaCO_3$ only.
   (d) $(NH_4)_2S$ and $SiO_2$ only.

7. How many orbitals are there in the p subshell of the $4^{th}$ principal energy level?
   (a) 3
   (b) 5
   (c) 6
   (d) 10

8. Consider the substances
   I      Methane
   II     Methanol
   III    Diamond

   In which of these substances are dispersion forces contributing to the forces of attraction that have to be overcome for the substance to melt?
   (a) I only
   (b) I and II only
   (c) I, II and III
   (d) none of the above

9. Consider the first five successive ionisation energies of an element measured in $MJ\ mol^{-1}$.
        0.802      2.43      3.66      25.0      32.9

   Which element is most likely to have this set of successive ionisation energies?
   (a) Boron
   (b) Carbon
   (c) Nitrogen
   (d) Magnesium

**SEE NEXT PAGE**

10. Which one of the following elements would be expected to have the highest second ionisation energy?
    (a)  Calcium
    (b)  Aluminium
    (c)  Magnesium
    (d)  Sodium

11. Which one of the following determines the identity of an element?
    (a)  The number of neutrons in the nucleus of its atoms
    (b)  The number of protons in the nucleus of its atoms
    (c)  The number of electron energy levels that are occupied in its atoms
    (d)  The electron configuration of its atoms

12. Four experiments were conducted in each of which four 0.100 mol L$^{-1}$ solutions were mixed as shown in I to IV
    I      Zinc nitrate + magnesium sulfate + barium chloride + sodium carbonate
    II     Barium  chloride + sodium nitrate + potassium chloride + aluminium sulfate
    III    Barium nitrate + potassium chloride + sodium nitrate + sodium hydroxide
    IV     Magnesium nitrate + sodium sulfate + potassium chloride + nickel sulfate

    Which of the experiments produced only a colourless solution when all the solutions were mixed?
    (a)  III only
    (b)  I and II only
    (c)  III and IV only
    (d)  I, II and III only

13. Which one of the statements about the activated complex produced during a chemical reaction is **not** correct?
    (a)  Of the species involved in the reaction, it is the one that has the highest energy.
    (b)  It is unstable and can decompose to either the reactants or the products.
    (c)  Its composition for a catalysed reaction is the same as for an uncatalysed reaction.
    (d)  Its energy will be the same for the forward and the reverse reaction.

14. Which one of the statements is true for an endothermic reaction?
    (a)  The potential energy of the products is less that the potential energy of the reactants.
    (b)  The reverse reaction has a higher activation energy than the forward reaction.
    (c)  The reverse reaction is exothermic.
    (d)  Once started the forward reaction will continue spontaneously.

**SEE NEXT PAGE**

Questions 15, 16 and 17 refer to the following equilibrium.

$$2C\ell O_{2(aq)} + 2OH^-_{(aq)} \rightleftharpoons C\ell O_2^-_{(aq)} + C\ell O_3^-_{(aq)} + H_2O_{(\ell)} \qquad \Delta H \text{ is negative}$$

Three separate changes can be made to the reaction solution. They are

I   A catalyst is added.
II  The solution is heated.
III Solid sodium hydroxide is added.

15. The equilibrium constant expression for the reaction is

(a) $\dfrac{[C\ell O_2]^2[OH^-]^2}{[C\ell O_2^-][C\ell O_3^-][H_2O]}$

(b) $\dfrac{[C\ell O_2^-][C\ell O_3^-][H_2O]}{[C\ell O_2]^2[OH^-]^2}$

(c) $\dfrac{[C\ell O_2]^2[OH^-]^2}{[C\ell O_2^-][C\ell O_3^-]}$

(d) $\dfrac{[C\ell O_2^-][C\ell O_3^-]}{[C\ell O_2]^2[OH^-]^2}$

16. Which of the changes will increase the rate of the forward reaction?
   (a) I only
   (b) I and II only
   (c) I and III only
   (d) I, II and III

17. Which of the changes will decrease the concentration of $C\ell O_2$ at equilibrium?
   (a) I only
   (b) II only
   (c) III only
   (d) II and III only

18. The correct order of increasing oxidising strength, that is from weakest to strongest, is
   (a) $C\ell_2 < A\ell^{3+} < Na^+$
   (b) $C\ell_2 < Cr^{3+} < Sn^{2+}$
   (c) $Mg^{2+} < A\ell^{3+} < C\ell_2$
   (d) $Sn^{2+} < Cu^+ < Fe^{2+}$

**SEE NEXT PAGE**

19. A saturated solution of tin (II) chloride in contact with excess undissolved solid can be represented by the equation

$$SnCl_{2(s)} \leftrightharpoons Sn^{2+}_{(aq)} + 2Cl^-_{(aq)}$$
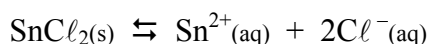
If a small amount of solid sodium chloride was added, a student proposed that a number of possible changes could occur as a new equilibrium is established. These include

I       The concentration of the $Cl^-$ ion will increase

II      The concentration of the $Sn^{2+}$ ion will decrease

III     The mass of solid $SnCl_2$ will increase

IV      The sodium chloride will not dissolve in this solution.

Of the changes the ones that will occur are

(a)    II only

(b)    IV only

(c)    II and III only

(d)    I, II and III only

20. Which one of the following reactions will occur spontaneously?

(a)    $Al^{3+}_{(aq)} + Cr_{(s)} \rightarrow Cr^{3+}_{(aq)} + Al_{(s)}$

(b)    $Br_{2(aq)} + 2NO_{2(g)} + 2H_2O_{(\ell)} \rightarrow 2Br^-_{(aq)} + 2NO_3^-_{(aq)} + 4H^+_{(aq)}$

(c)    $Mn^{2+}_{(aq)} + I_{2(s)} + 2H_2O_{(\ell)} \rightarrow MnO_{2(s)} + 2I^-_{(aq)} + 4H^+_{(aq)}$

(d)    $Fe^{2+}_{(aq)} + Cu^{2+}_{(aq)} \rightarrow Fe^{3+}_{(aq)} + Cu^+_{(aq)}$

21. Which one of the following reactions represents a redox reaction?

(a)    $Al(OH)_{3(s)} + OH^-_{(aq)} \rightarrow [Al(OH)_4]^-_{(aq)}$

(b)    $4NH_{3(aq)} + Cu(OH)_{2(s)} \rightarrow [Cu(NH_3)_4]^{2+}_{(aq)} + 2OH^-_{(aq)}$

(c)    $Zn_{(s)} + 2OH^-_{(aq)} + 2H_2O_{(\ell)} \leftrightharpoons [Zn(OH)_4]^{2-}_{(aq)} + H_{2(g)}$

(d)    $SO_3^{2-}_{(aq)} + 2H^+_{(aq)} \rightarrow SO_{2(g)} + H_2O_{(\ell)}$

22. In which one of the following compounds does chlorine have the lowest oxidation number?

(a)    $HClO_3$

(b)    $HClO_2$

(c)    $Cl_2$

(d)    $Ca(ClO_3)_2$

23. An electrochemical cell has a cell potential of +2.42 V measured at standard conditions. The equation for the reaction in the cell can be represented as

$$2Au^{3+}_{(aq)} + 3Se^{2-}_{(aq)} \rightarrow 2Au_{(s)} + 3Se_{(s)}$$

The standard reduction potential, E°, for the $Se^{2-}$/Se half reaction is

(a)    −3.92 V

(b)    −0.92 V

(c)    +0.92 V

(d)    +3.92 V

24. Which one of the following equations best represents the reaction occurring in a fuel cell?

    (a) $2MnO_2 + 2NH_4C\ell + Zn \rightarrow ZnC\ell_2 + 2NH_3 + H_2O + Mn_2O_3$

    (b) $Zn + Ag_2O \rightarrow ZnO + 2Ag$

    (c) $2PbSO_4 + 2H_2O \rightarrow PbO_2 + Pb + 2H_2SO_4$

    (d) $2H_2 + O_2 \rightarrow 2H_2O$

25. An Element X forms a hydride with a formula $XH_3$. The element is

    (a) Boron

    (b) Magnesium

    (c) Silicon

    (d) Sulfur

26. Electrolysis is used to reduce alumina, $A\ell_2O_3$, to aluminium metal. The reason for this is

    (a) Alumina is easily reduced

    (b) Aluminium is a strong reducing agent and so is easily oxidised

    (c) Electrical energy is cheap

    (d) Alumina is soluble in molten cryolite

27. Consider the statements about acid-base reactions.

    I    Acid-base reactions involve the transfer of hydrogen ions.

    II   At equivalence point of an acid base reaction the pH of the resulting solution is 7.

    III  Hydrogen ions and hydroxide ions are involved in acid-base reactions

    Which of the statements are always true?

    (a) I only

    (b) III only

    (c) I and II only

    (d) I, II and III

28. The pH of a solution produced from mixing 10.0 mL of 0.0100 mol $L^{-1}$ hydrochloric acid solution and 10.0 mL of 0.0100 mol $L^{-1}$ barium hydroxide solution is

    (a) 2.30

    (b) 7.00

    (c) 11.7

    (d) 12.0

29. Which one of the following reactions is **not** an acid-base reaction?

    (a) $HC\ell O_{(aq)} + H_2O_{2(aq)} \rightarrow C\ell^-_{(aq)} + H_2O_{(\ell)} + H^+_{(aq)} + O_{2(g)}$

    (b) $HS^-_{(aq)} + H_2O_{(\ell)} \rightarrow H_2S_{(aq)} + OH^-_{(aq)}$

    (c) $HC\ell O_{(aq)} + CH_3COO^-_{(aq)} \leftrightarrows C\ell O^-_{(aq)} + CH_3COOH_{(aq)}$

    (d) $CH_3COOH_{(aq)} + CO_3^{2-}_{(aq)} \rightarrow CH_3COO^-_{(aq)} + HCO_3^-_{(aq)}$

**SEE NEXT PAGE**

30. In the reaction

    $Cl_{2(aq)} + 2OH^-_{(aq)} \rightarrow Cl^-_{(aq)} + ClO^-_{(aq)} + H_2O_{(l)}$

    Chlorine is acting as

    (a) an acid only

    (b) a reducing agent only

    (c) an oxidising agent only

    (d) a reducing agent and an oxidising agent.

**END OF PART I**

**PART 2**      **(70 marks)**

Answer ALL questions in Part 2 in the spaces provided below.

1.      Write equations for any reactions that occur in the following procedures. If no reaction occurs write "no reaction".

In each case describe **in full** what you observe, including any
*     colours
*     odours
*     precipitates (give the colour)
*     gases evolved (give the colour or describe as colourless)
If a reaction occurs but the change is not visible, you should state this.

(a)     A cleaned piece of lead metal is placed in an iron (III) nitrate solution.

Equation: _____

Observation: _____

_____

[3 marks]

(b)     A saturated solution of calcium chloride is mixed with a solution of $5.00 \ mol \ L^{-1}$ sulfuric acid solution.

Equation: _____

Observation: _____

_____

[3 marks]

(c)     Iron (II) sulfide solid is placed into a $6.00 \ mol \ L^{-1}$ hydrochloric acid solution.

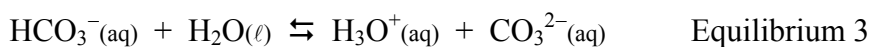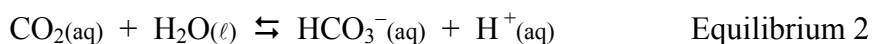Equation: _____

Observation: _____

_____

[3 marks]

(d)     Solid chromium (III) oxide is mixed with excess hot concentrated sodium hydroxide solution

Equation: _____

Observation: _____

_____

[3 marks]

**SEE NEXT PAGE**

2. When carbon dioxide is dissolved in water a number of equilibria are established. Three of these are represented by the following equations.

$$CO_{2(g)} \rightleftharpoons CO_{2(aq)}$$ Equilibrium 1

$$CO_{2(aq)} + H_2O_{(\ell)} \rightleftharpoons HCO_3^-{}_{(aq)} + H^+{}_{(aq)}$$ Equilibrium 2

$$HCO_3^-{}_{(aq)} + H_2O_{(\ell)} \rightleftharpoons H_3O^+{}_{(aq)} + CO_3^{2-}{}_{(aq)}$$ Equilibrium 3

(a) Explain why a student observed that carbon dioxide is more soluble in pure water than in vinegar.

(b) Explain how you could further increase the solubility of carbon dioxide in an aqueous solution at atmospheric pressure.

[4 marks]

3. Complete the table by writing the IUPAC name or drawing a structure

| Structure | IUPAC Name |
|---|---|
| $C\ell_2C{=}CHC\ell$ | |
| $CH_3CHCH_2CCH_3$ with $CH_3$ group above central C, $C\ell$ below the CH, and $CH_3$ below central C | |
| | 1-propylcyclopentene |
| | Methyl ethanoate |

[8 marks]

**SEE NEXT PAGE**

4.  Describe a chemical test that could be used to distinguish the following pairs of substances. You should describe the observations for each substance as the test is applied.

Solid sodium sulfate and solid sodium sulfite

| Describe test | Observation for sodium sulfate | Observation for sodium sulfite |
|---|---|---|
|  |  |  |

Sulfuric acid solution and hydrochloric acid solution

| Describe test | Observation for sulfuric acid solution | Observation for hydrochloric acid solution |
|---|---|---|
|  |  |  |

[6 marks]

5.  Write the formula for three (3) different species that have an electron configuration $1s^2 \, 2s^2 \, 2p^6 \, 3s^2 \, 3p^6$.

_____

[3 marks]

6.  (a) Silver metal can be purified by a process called electro-refining. Write the equations that occur at the anode and cathode.

Anode _____

Cathode _____

(b) Electroplating nickel onto iron can be achieved using nickel chloride solution and a complexing agent to reduce the concentration of the nickel ions. Write the equations that occur at the anode and cathode.

Anode _____

Cathode _____

[4 marks]

**SEE NEXT PAGE**

7. Write the name or formula of one example of each of the following.

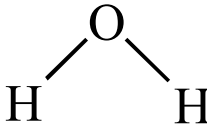| Description | | Name or Formula |
|---|---|---|
| (a) | An element that forms a covalent network compound with oxygen. | |
| (b) | The oxidising agent used to oxidise gold and form the gold-cyanide complex, $[Au(CN)_2]^-$. | |
| (c) | An ion containing sulfur that can behave as an acid or a base. | |
| (d) | A molecule that often becomes a ligand in a complex ion. | |
| (e) | A compound that can be used to produce hydrogen and chlorine in an electrolytic process. | |
| (f) | A diatomic molecular gas that produces a strong acid when dissolved in water. | |
| (g) | A compound that contains three carbon atoms and reacts with sodium to produce an ionic compound. | |

[7 marks]

8. The pH of a 0.00001 mol $L^{-1}$ potassium hydroxide solution is 9. The pH of a 1.0 mol $L^{-1}$ ammonia solution is also about 9. Explain these observations using equations to support your explanation.

[4 marks]

**SEE NEXT PAGE**

9. For each species listed below draw the structural formula representing all valence electron pairs and draw the shape of the molecule as indicated in the example

| Species | Structural formula showing all valence electrons | Draw shape of molecule or ion |
|---|---|---|
| *Example* water $H_2O$ | H :O: H | |
| Tellurium (IV) oxide $TeO_2$ | | |
| Chloric acid $HC\ell O_3$ | | |
| Germanate ion $GeO_3^{2-}$ | | |

[9 marks]

10. (a) Write an equation for the reduction of iron (III) oxide that occurs in a blast furnace.

(b) (i) Describe ways in which the yield of iron from the reduction of iron (III) oxide could be increased.

(ii) Are these ways to increase the yield used in practice? Give an explanation.

(c) Describe two ways in which iron obtained from a blast furnace is modified so that it has more useful properties.

[7 marks]

11. Write the name of the intermolecular force that is mostly responsible for the difference observed in the boiling points of the following pairs of substances.

| Substances | | | Name of intermolecular force |
|---|---|---|---|
| $CH_3NH_2$<br>BP = −6.3 °C | and | $CH_3CH_3$<br>BP = −88.6 °C | |
| $CH_3CH_2OH$<br>BP = 78.5 °C | and | $CH_3CH_2CH_2CH_2OH$<br>BP = 117.5 °C | |
| $\overset{\displaystyle O}{\overset{\|}{CH_3C}} CH_3$<br>BP = 56.2 °C | and | $CH_3CH_2CH_2CH_3$<br>BP = −0.5 °C | |

[6 marks]

**END OF PART 2**

**SEE NEXT PAGE**

**There are no questions on this page**

**PART 3    (50 marks)**

Answer ALL questions in Part 3. The calculations are to be set out in detail in this Question/Answer Booklet. Marks will be allocated for correct equations and clear setting out, even if you cannot complete the problem. When questions are divided into sections, clearly distinguish each section using (a), (b) and so on. Express your final numerical answers to three (3) significant figures where appropriate, and provide units where applicable. Information which may be necessary for solving the problems is located on the separate Chemistry Data Sheet.  Show clear reasoning: if you don't, you will lose marks.

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1.    In the first step of the process for the production of pure titanium (IV) oxide powdered synthetic rutile (impure titanium (IV) oxide) is reacted at a temperature of around 950 °C with carbon monoxide and chlorine to produce gaseous titanium (IV) chloride and carbon dioxide.

    (a)    Write an equation for the reaction between titanium (IV) oxide, carbon monoxide and chlorine.

[2 marks]

    (b)    Calculate the mass of synthetic rutile that will react with 3.00 kL of carbon monoxide measured at 950 °C and 105.0 kPa if the purity of the synthetic rutile is 93.0%.

[6 marks]

**SEE NEXT PAGE**

2.  An analytical chemist working on an organic compound extracted from seaweed found that it contained only the elements carbon, oxygen, hydrogen and bromine.
    When he burnt a 1.376 g pure sample of the compound in pure oxygen he collected 0.6047 L of carbon dioxide at STP and 0.4052 g of water.

    In a second experiment he used a sample of 1.573 g of the pure compound. In this experiment all the bromine was converted to hydrogen bromide which was dissolved in 100.0 mL of water. This required 55.73 mL of a 0.1845 mol $L^{-1}$ potassium hydroxide solution for complete neutralisation.

    (a)  Calculate the empirical formula of the compound.

    [7 marks]

    (b)  A third sample of the compound, mass 1.228 g was vapourised by heating it to 250 °C at a reduced pressure of 55.0 kPa. The gas produced occupied a volume of 0.6347 L at these conditions. Calculate the molar mass for the compound and then determine the molecular formula.

    [3 marks]

    (c)  The chemist tested some of the compound's chemical properties. Observations for the two tests he conducted are as follows.

    1.  Addition of a small piece of sodium metal resulted in the formation of colourless bubbles on the metal surface. The metal eventually dissolved.
    2.  Addition of a solution of sodium hydroxide produced no visible change, however, a small increase in the temperature was noted and the resulting solution was found to be a good electrical conductor.

    From these observations draw the structure of the compound and write its IUPAC name.

    [2 marks]

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**SEE NEXT PAGE**

3.  A calcite crystal, pure calcium carbonate, of mass 22.3 g was placed into 98.0 mL of a 4.10 mol $L^{-1}$ nitric acid solution.

    (a) What volume of carbon dioxide will be collected at STP assuming that 7.70% of the gas remains in solution.

    [6 marks]

    (b) Calculate the amount of excess reactant , in moles, that remains after the reaction has stopped.

    [2 marks]

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4. A jeweller was investigating the best method of plating white gold with rhodium. She connected two electrolytic cells in series and allowed them to operate for 2.55 hours. The first cell contained a solution of copper (II) nitrate with copper electrodes and the second cell contained a solution of rhodium ions.
1.37 g of copper metal was deposited in the first cell and 1.48 g of rhodium was deposited in the second cell.

(a) Write an equation for the reaction at the cathode in the first cell, that is the copper cell.

[1 mark]

(b) Calculate the average current in the cells during the period of operation.

[4 marks]

(c) Determine the charge on the rhodium ion

[3 marks]

(d) To obtain a coherent, even coating on the jewellery, the jeweller found that a current of 15.0 mA was required. Calculate the time required to electroplate a ring with 0.281 g of rhodium at a current of 15.0 mA.

[4 marks]

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5. Spinach is an edible plant that contains a small amount of oxalic acid.
   In an experiment to determine the percentage by mass of oxalic acid ($H_2C_2O_4$) in spinach, a standard $5.00 \times 10^{-6}$ mol $L^{-1}$ potassium permanganate solution is prepared, acidified with dilute sulfuric acid then titrated against a sample of the solution prepared from the juice of the crushed spinach.
   49.7 mL of juice is obtained from a 98.6 g sample of spinach then diluted to a volume of 250.0 mL. 20.0 mL samples of this solution were titrated with the standard permanganate solution. The results are recorded in the table.

| | Rough Estimate (mL) | 1st trial (mL) | 2nd trial (mL) | 3rd trial (mL) | 4th trial (mL) |
|---|---|---|---|---|---|
| Initial reading | 0.39 | 15.59 | 30.27 | 3.42 | 1.87 |
| Final reading | 15.59 | 30.27 | 44.56 | 18.15 | 16.51 |
| Volume used | | | | | |

Calculate the oxalic acid content of the spinach in parts per million.

[10 marks]

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**END OF PART 3**

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**PART 4** (20 marks)

Answer the following extended answer question. Where applicable use equations, diagrams and illustrative examples of the chemistry you are describing.

Marks are awarded for the relevant chemical content of your answer, but you will lose marks if what you write is unclear or lacks coherence. Your answer should be presented in about 1½ - 2 pages. Begin your answer on the lined page following the end of the questions.

1. Ethene can be used as the starting material for the production of many useful compounds. A researcher for a chemical manufacturing company was given the task of devising reactions for the production of three chlorohydrocarbons and five other compounds all using ethene as the starting material. The other materials the researcher was supplied with were chlorine, hydrogen chloride, water, potassium permanganate and concentrated sulfuric acid. The researcher found a number of separate reactions were required to produce some of the compounds. The researcher was then required to write a report outlining the results of his investigations.

   Write the report for the researcher clearly stating

   (a) the name and structure of the compounds produced

   (b) the type of reaction, reactants used, reaction conditions and a balanced equation for the production of each compound

**END OF QUESTIONS**

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**END OF PAPER**